1901, in a moist silo, and at the same time others were put in a dry cellar, those in the latter being examined from time to time. The basal portions of the petioles of the diseased leaves were left attached to the crown of each beet. In a month or so the petioles had been partially or wholly rotted by the Phyllosticta and in two months the decay had penetrated the crowns of the beets producing the typical Phoma rot. Cultures carefully removed with a hot scalpel from the interior portions of the diseased tissues of the petioles and roots developed cultures of Phoma.

In the study of cultures of the fungus from both leaves and roots, under certain conditions there were produced guttulated spores, but normally in either case the spores were free from either guttules or oil globules. This work indicates that in the case of the beet we have only one species of fungus which according to priority of generic names will be placed in the genus Phoma, and that the various species of Phoma and Phyllostica described upon sugar beets, garden beets and mangels are identical. A synonymy of names will be published later.

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NOTE ON THE GENUS HARPOCHYTRIUM.

GEO. F. ATKINSON.

At the suggestion of the editor I have prepared this short note on the genus HARPOCHYTRIUM for the JOURNAL OF MYCOLOGY — for the purpose of calling the attention of American students to these interesting Chytrids, to give brief characters of the genus, and the at present three species. I have also added a brief suggestion or two not brought out in my monographic treatment of the genus.[1]

In that paper I have described the development, formation of sporangia, formation and movement of zoospores, attachment to host, parasitism, relationship of forms, origin and distribution of species, and synonymy.

The genus is one of the *Chytridiales* and is probably best located in the family *Rhizidiaceae.* The plant body is elongated, narrowly fusiform, usually tapering to a point at the free end, but often more or less rounded at the basal end. Some of the individuals are straight but more often they are curved, sometimes strongly so. The plant is either sessile or attached to the host by a very short, slender stalk, or by a more or less elongated

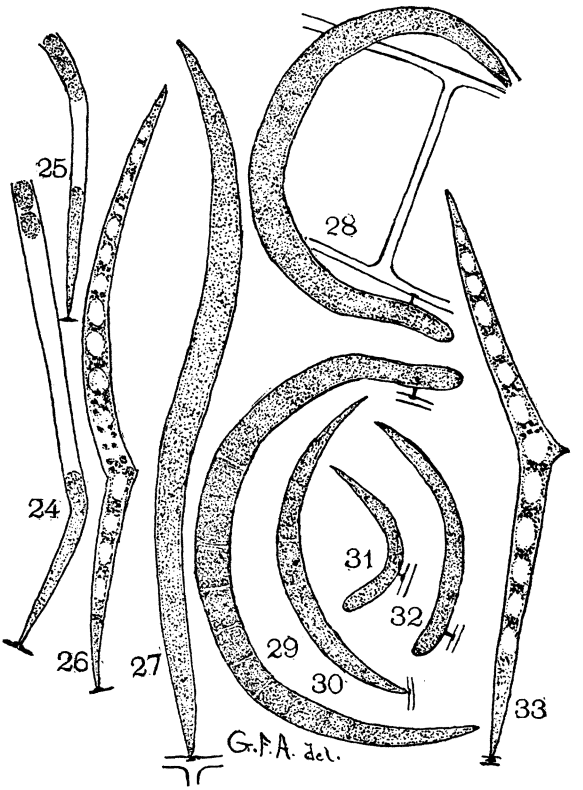
[1] The Genus Harpochytrium in the United States, Ann. Mycol. 1: 479-502, Pl. 10 and text Figures A-F, November 1903. [Ausgegeben am 10. December 1903.]

stalk, the latter being formed when the zoospore is prevented from coming in contact with the host cell by an envelope of gelatine with which some algae are provided. Even in the apparently sessile forms there is a short slender stalk which pierces the outer lamella of the host cell wall. The stalk expands into a disk shaped holdfast in the middle lamella, but in the smallest species this has not been certainly determined. When the plant is mature it is divided by a thin cross wall near the base into a small sterile basal part, and an outer long part, the sporangium. The tip of the sporangium gelatinizes and permits the escape of the zoospores which are oval and 1-ciliate. The zoospores either swim about with great rapidity in the water, or first show slight amoeboid movements, and then dart off with great rapidity, and finally come to rest on the host or in the gelatinous sheath surrounding the host, and attach themselves. The sterile base now forms a secondary sporangium in the empty one, and this may be repeated several times as in *Saprolegnia.* The plant probably is not derived from *Saprolegnia* by degeneration, but more likely is an example of the differentiation of a simple chytrid into a sterile and fertile part, the sterile part perhaps representing a rudimentary hypha.

My first knowledge of the genus was in 1896, when I found it at Ithaca, N. Y., parasitic on *Spirogyra* and rarely on *Zygnema.* This species proved to be *Harpochytrium hedenii* Wille, which has also been found in France, Tibet (Asia), and Patagonia (S. Am.), and Sweden.

Since the publication of my paper in the Annales Mycologici (l. c.) I have received drawings of a species of *Harpochytrium* from Dr. Lagerheim, a notice of which it seems desirable to incorporate in this note. His pencil sketches I have redrawn and they are here reproduced in text figures 24-26. These plants were growing on threads of *Vaucheria.* They are interesting as showing from the illustration that the base of the organism does not penetrate the cell wall, but expands into a disk-like holdfast and absorbent plate on the outer surface of the wall. This may be because of some peculiarity of the cell wall of the host. I am inclined to think that in some cases the form from Tibet is furnished with the disk-like holdfast on the outside of the cell wall, especially in the forms on threads of *Zygnema* which are covered with a thin slime layer. The slime would tend to prevent the zoospore from coming in contact with the cell wall directly and a very short slender stalk is developed to reach the host just as a longer stalk is developed in *H. hyalothecae* on the desmids with a thick slime layer. Text figure 26 represents a peculiar form of the plant, with a tendency to develop a short conic out-growth at one side as if there was a tendency to branch. A similar form I found in 1896 at Ithaca, but for

which there was not room in the Plate illustrating my paper in the Annales (see text Fig. 33).



HARPOCHYTRIUM HEDENII Wille. Figs. 24–26, on Vaucheria, Sweden; 27, 28, on Zygnema, Patagonia; 29–32, on Zygnema, Tibet; 33, on Spirogyra, United States.

These specimens from Dr. Lagerheim I think without doubt belong to *H. hedenii.* They were found growing on *Vaucheria* in an aquarium in the Botanical Institute of the Högskolan, Stockholm. Several years earlier Dr. Lagerheim found what he thinks the same organism on *Microspora stagnorum* in Stadshagen in Stockholm. He has searched again this last autumn for the same but the locality is so changed he was not able to find a trace of it. Dr. Thaxter of Harvard University informs me that he has found a species of *Harpochytrium* (which I suppose is *H. hedenii*) on *Saprolegnia* in Cambridge, Mass.

With regard to the wide distribution of *H. hedenii* some would probably attribute the forms in such widely separated areas as Tibet, Patagonia, and the United States, as due to a polyphyletic origin. It seems more reasonable, however, to regard them as having a common origin. I have shown in my

paper (l. c.) how it is quite possible that in Tertiary times the species could easily have passed from Europe to North America or *vice versa*. It is very likely that in even earlier times the condition of climate and topography of the two hemispheres might have been such as to have caused a wide distribution north and south before the modern types of the higher plants were evolved. The forms from Patagonia are shown in text Figures 27, 28, and those from Tibet in text Figures 29-32. The latter show peculiar variations in form.

The species on which the genus was founded in 1890 by Lagerheim is *H. hyalothecae,* found on *Hyalotheca dissiliens* (consult the accompanying Plate). It was later found by Gobi in Finland, and by myself at Ithaca, N. Y., in 1903. At the same time (1903) the new species *H. intermedium* was found. Bibliographic references concerning the above species are given in the brief description of species at the close of this paper.

The plants seem to show some relationship to such forms of the genus *Rhizophidium* as *R. lagenula* (A. Braun) Schroeter,[2] and the example of *Chytridium lagenula* A. Braun[3] which he figures on *Conferva floccosa* (*bombycina*) looks very much like a young form of *Harpochytrium hedenii* Wille, but the description and figure are too imperfect to be certain, while the mature forms of *C. lagenula* on *Melosira varians* are quite certainly generically distinct, as is also *R. fusus* Zopf.[4]

Gobi[5] thinks the organism is an animal belonging to the *Flagellates,* and that algae like *Characium, Ophiocytium,* and *Sciadium* have been evolved from it. Wille,[6] while agreeing with Gobi that it shows a phylogenetic relationship with such algae, believes it is a chlorophylless alga derived from the green forms, much as he thinks the chlorophylless form *Chionaster nivalis* (Bohlin) Wille (*Cerasterias nivalis* Bohlin)[7] has been derived by descent from the chlorophyll bearing genus *Tetraedon.* It does not seem necessary, however, to search in either of these directions for the relationship of the genus since a more probable and closer relationship exists with such species of *Rhizophidium* as I have mentioned above. A consideration of all the facts seems also to show that the organism is one of the *Chytridiales,* and the

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[2] Rab. Krypt. Flora, *4,* p. 99.

[3] A. Braun. Ueber Chytridium eine Gattung einzelliger Schmarotzer gewæchse auf Algen und Infusorien. Abhandl. d. k. Akad. f. Wiss. zu Berlin, pp. 21-83, Taf 1-4 (1885), 1856.

[4] Nova Acta physico-medico=Verhandl. d. Leopold. Car. Acad. d. Naturforscher, *47,* p. 199, Tab. 18, Fig. 9-12, 1884, Nuernberg, Erlangen, etc.

[5] Gobi, Chr. Fulminaria mucophila, Nov. gen. et sp. Script. Bot. Hort. Univ. Imp. Petrop. Fascic. *15,* pp. 283-292, Tab. VII, Fig. 1 & 2, 1899.

[6] Willie, N. Ueber Cerasterias nivalis Bohlin. Nyt Mag. f. Naturvidenskab. *41,* pp. 171-176, 1903.

[7] Bolhin, K. Snöalgen frán Pite Lappmark, Botaniska Notiser, Lund. 1893.

peculiar proliferation of the sporangia is known in at least one other genus of chytrids, in *Cladochytrium,* according to Nowakowski[8] in *Cladochytrium elegans* (Tab. 6, Fig. 14-17) and according to Clinton in *Cladochytrium alismatis.*[9]

Brief characterizations of the species might be given here with synonymy.

1. HARPOCHYTRIUM HYALOTHECAE Lagerheim, Hedw., 29, 142, 143, 1890. Plant body 20-60μ x 1.5-2μ attached at the basal end by a long and very slender stalk since the hosts are covered by a thick gelatinous layer; the base of the plant body is within the slime while the larger part projects beyond; fusoid and slightly curved, either projecting straight from the stalk, or bent, sometimes nearly to a right angle with it. Zoospores in one row, correspondingly small. Syn., *Harpochytrium hyalothecae* Schroet. in Rabh. Krypt. Flora 4. Pilze, p. 114, 1892; *Fulminaria mucophila* Gobi, Script. Bot. Fasc. *15,* 283-292, 1899; *Fulminaria mucophila* Wille, Nyt Mag. f. Naturvidenskab. 41, p. 175, 1903. Distribution, on Hyalotheca dissiliens, in Finnland, Sweden and U. S. of North America (Ithaca,, N. Y.) and on Sphaerozosma vertebratum, Cosmocladium species, Dictyosphaerium species, Finnland.

2. HARPOCHYTRIUM HEDENII, Wille, Petermann's Mitteilungen, Erg.-Heft no. 131, S. 371, 1900. Plants 80-180μ x 4-10μ the larger diameter accompanying the longer forms. Zoospores usually in a single row, 4-6μ, but in the broader forms in two to three rows. Plant sessile or with a very short stalk on some species of Zygnema perhaps those species which have a thin gelatinous envelope (I have found that many of the threads of Zygnema from the Tibet material have a thin gelatinous sheath). Syn., *Rhabdium acutum* Dangeard, Ann. Mycol. 1, 61-64, 1903; *Fulminaria hedenii* Wille, Nyt Mag. f. Naturvidenskab. 41, p. 175, 1903. Distribution, on Spirogyra and Oedogonium, France; on different species of Spirogyra, rarely on Zygnema, rarely on Harpochytrium hedenii, U. S. of North America (Ithaca, N. Y.); on Zygnema and Spirogyra in Tibet, Asia; and on Zygnema in Patagonia, S. Am.

3. HARPOCHRYTRIUM INTERMEDIUM Atkinson, Ann. Mycol. 1, 494 & 500, Pl. 10, Fig. 22, 23. 1903. Plant body 40-70μ x 3-4μ narrowly fusoid, straight or slightly curved, sessile. Zoospores in one row, correspondingly small.

EXPLANATION OF PLATE.

(Plate reproduced from the November No. of Annales Mycologici.)

HARPOCHYTRIUM HEDENII Wille.

Figs. 1, 2, 3, 4, 5, Young stage of plant on *Spirogyra* and *Zygnema,* developed in cell culture.
Fig. 6, Mature plant.
Fig. 7, Old plant with two empty sporangia and young tertiary sporangium growing out in the old secondary one.
Figs. 8, 9, Plants half grown showing large and long vacuoles separated by granular protoplasm. Both of these plants became freed from their attachment to the host, the one illustrated in Fig. 8 was attached at two points, one point directly at the base, the other upon the side a short distance from the end. The plant in Fig. 9 was attached at one point on the side, a little distance from the end. Here the short slender stalk and the disk-like expansion is shown. The plants are usually attached directly at the end, but in some cases, probably where the zoospore rests at first against the host cell on its side, the haustorium and absorbent disk are formed on the side.
Fig. 10, Plant coiled in the form of a serpent on the side of the *Spirogyra* thread.
Fig. 11, Old plant with empty sporangium and young secondary sporangium developing within.

[8] Nowakowski, L. Beiträge zur Kenntnis der Chytridiaceen. Cohn's Beitr. z. Biol. d. Pflanzen, *2,* p. 72-100, Tab. 3-6, 1876.

[9] Cladochytrium alismatis. Bot. Gaz., *33,* pp. 49-61, pl. 2-4, 1902.

Fig. 12, Mature plant, zoospores escaping, sterile basal part limited by thin wall which is arched outward slightly because of the endosmotic pressure in the protoplast, and the removal of the pressure within the primary sporangium.
Fig. 13, One individual of *Harpochytrium* attacked by another, the parasitic one only half the size and age of the host individual.
Fig. 14, Later stage, showing degeneration of the host individual and the increased size of the parasitic individual.
Fig. 15, Mature individual attached at the side a short distance from the base.
Fig. 16, Mature individual attached at the end at a point between two adjacent *Spirogyra* cells.
Fig. 17, Same plant with zoospores escaping. This plant was kept in cell culture and the secondary sporangium from the sterile basal part began to grow before the developed zoospores escaped, and was forced out slightly at one side. The apex of individuals in Figs. 15, 16, show the peculiar condition shortly before formation of zoospores. In Fig. 17, amoeboid movement of some zoospores shown in the sporangium and also escaping.
Fig. 18, The zoospore after escaping from sporangium still showing amoeboid movement.
Fig. 19, Five individuals showing stages in attachment and elongation of zoospores. Figs. 6, 7, 11, 12, 13, 14, show the disk-like holdfast and absorbent disk between the outer and inner lamellae of cell wall.
Figs. 1–19 from specimens collected at Ithaca, N. Y.
Fig. 24, after Dangeard.

HARPOCHYTRIUM HYALOTHECAE Lagerheim.

Fig. 20, Showing two young individuals attached to cell of host (Hyalotheca dissiliens), one of the zoospores still within the slime and just having developed the slender stalk; the other individual, the zoospore having elongated and the outer end projecting beyond the slime sheath.
Fig. 21, Mature individual attacked by a filamentous bacterium.
Figs. 20, 21, from specimens collected at Ithaca, N. Y.
Fig. 25, after Gobi.
Fig. 26, after Lagerheim.

HARPOCHYTRIUM INTERMEDIUM Atkinson.

Fig. 22, Half grown individual attached to *Conferva utriculosa*, showing disk-like haustorium between outer and inner lamellae of cell wall.
Fig. 23, Mature individual with empty primary sporangium, and young secondary sporangium developing.
Figs. 22, 23, from material collected at Ithaca, N. Y.

CULTURES OF UREDINEAE IN 1903.[1]

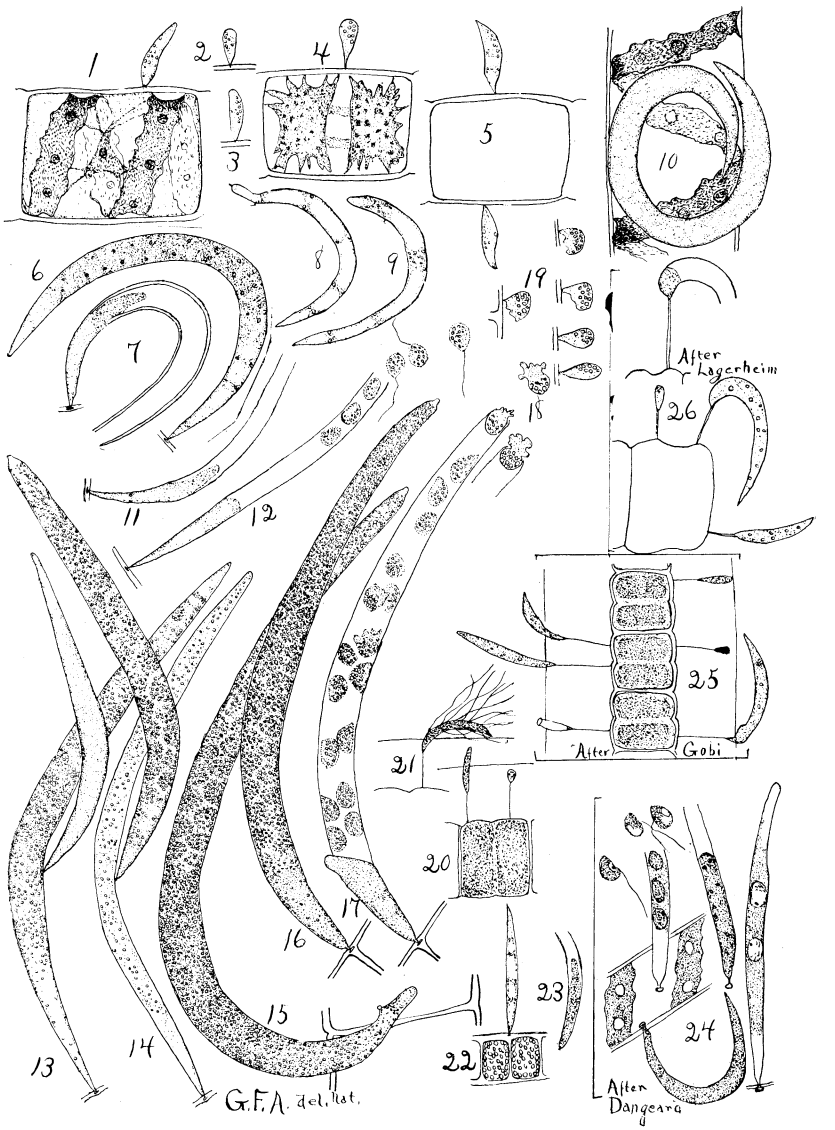
J. C. ARTHUR.

The present article forms the fourth of a series of reports[2] by the author upon the cultures of plant rusts. They cover the years from 1899 to the present inclusive. This report is devoted both to autoecious and heteroecious species, among which the grass and sedge rusts have had a prominent place. The number of species studied and the number of cultures made have fallen off somewhat from last year, partly because it was late in the spring before assistance was secured to carry on the work, and partly because a less number of collections of teleutospores and field observations were obtained upon which to base the work. The results however, fully equal in interest and importance those of last year, or possibly exceed them.

The expense of additional assistance in carrying on the work, and to some extent the expense of procuring material, was

[1] Read before the Botanical Society of America, St, Louis, December 30, 1903.

[2] See Bot. Gaz. *29*:268-276; Jour. Mycol. *8*:51-56; and Bot. Gaz. *35*:10-23.



THE GENUS HARPOCHYTRIUM